Claims

1. A gradient index plastic optical article comprising:

a polymeric sheathing, which is at least partially transparent to light at at least one wavelength, including a sheathing polymer and a sheathing dopant, the sheathing dopant having a refractive index which is less than that of the an equivalent polymeric sheathing without the sheathing dopant; and

a polymeric core, polymerized within said sheathing, including a core polymer, said core being at least partially transparent to light at at least one wavelength and having a gradient in refractive index in a specific direction that is established by redistribution of a dopant during polymerization of a core solution including a polymerizable core monomer.

2. The article of claim 1, wherein said sheathing dopant lowers the refractive index of the polymeric sheathing by at least 0.0005 compared to an equivalent sheathing without said sheathing dopant.

3. The article of claim 1, wherein said sheathing dopant is present in the polymeric sheathing at an overall concentration less than 35 %wt.

4. The article of claim 1, wherein said sheathing dopant is present in the polymeric sheathing at an overall concentration less than 20 %wt.

5. The article of claim 1, wherein said sheathing dopant is present in the polymeric sheathing at an overall concentration less than 15 %wt.

6. The article of claim 1, wherein the interface between said polymeric sheathing and said polymeric core is essentially free of visible bubbles.

7. The article according to claim 1, wherein said polymeric sheathing and said polymeric core are both at least partially transparent to the same at least one wavelength of light.

8. The article of claim 1, wherein said polymeric core further includes a core dopant

9. The article according to claim 8, wherein the refractive index of the central axis of the polymeric core exceeds that of the polymeric sheathing by at least 0.01.

10. The article according to claim 9, wherein the overall concentration of said core dopant in said polymeric core is less than 12 %wt.

11. The article of claim 9, wherein said article has a maximum service temperature of at least 40 degrees C.

12. The article of claim 8, wherein said core dopant has a concentration gradient within said core in the same direction as the gradient in refractive index.

13. The article of claim 12 wherein, said polymeric core further includes said sheathing dopant having a concentration gradient within the core in a specific direction opposite that of said direction of the concentration gradient of the core dopant.

14. The article of claim 1, wherein the refractive index at the central axis of said polymeric core is greater than the refractive index of said polymeric sheathing, where said article conducts light at at least one wavelength with an attenuation less than 500 dB/km.

15. The article of claim 14, wherein said article conducts light at at least one wavelength with an attenuation less than 200 dB/km.

16. The article of claim 1, wherein the shape of the article is an essentially cylindrical rod.

17. The article of claim 16, wherein said rod is hot-drawn into a fiber that conducts light having a diameter less than said rod at a draw rate of at least 3 m/min.

18. The article of claim 1, wherein the shape of the article is an essentially cylindrical fiber having an outer diameter less than 1 millimeter.

19. The article of claim 1, wherein said sheathing polymer and said core polymer are formed from different polymerizable monomers.

20. The article of claim 1, wherein said sheathing polymer and said core polymer are formed from the same polymerizable monomer.

21. The article of claim 20, wherein the polymerizable monomer is methyl methacrylate.

22. The article of claim 1, wherein said sheathing dopant is dimethyl sebatate.

23. The article of claim 1, wherein said sheathing dopant is diisobutyl adipate.

24. The article of claim 1, wherein said sheathing dopant is 2,2,4-trimethyl-1,3-pentanediol diisobutyrate.

25. The article of claim 1, wherein said sheathing dopant is diethyl succinate.

26. The article of claim 8, wherein said core dopant is benzyl benzoate.

27. The article of claim 8, wherein said sheathing dopant is dimethyl sebatate and said core dopant is benzyl benzoate.

28. The article of claim 8, wherein said sheathing dopant is diisobutyl adipate and said core dopant is benzyl benzoate.

29. The article of claim 8, wherein said sheathing dopant is 2,2,4-trimethyl-1,3-pentanediol diisobutyrate and said core dopant is benzyl benzoate.

30. The article of claim 8, wherein said sheathing dopant is diethyl succinate and said core dopant is benzyl benzoate.

31. A method for forming a gradient index plastic optical article comprising:

(a) forming a tube of polymeric sheathing material that is at least partially transparent to light at least one wavelength from at least one polymerizable sheathing monomer including a sheathing dopant; and

(b) forming a polymeric core that is at least partially transparent to light at at least one wavelength within the tube formed in step (a), with said core having a gradient in refractive index in a specific direction by:

(i) filling said tube with a composition including at least one polymerizable core monomer; and

(ii) polymerizing said core monomer.

32. The method of claim 31, wherein said tube of sheathing material is formed by:

(a) supplying a cylindrical polymerization container;

(b) placing a quantity of a composition including said at least one polymerizable sheathing monomer and said sheathing dopant into said container; and

(c) polymerizing said sheathing monomer to form a hollow polymeric tube.

33. The method of claim 31, wherein said sheathing dopant has a refractive index less than said polymerizable sheathing monomer when polymerized without the sheathing dopant.

34. The method of claim 31, wherein the composition in step (b)(i) further includes a core dopant.

35. The method of claim 34, wherein the core dopant has a refractive index greater than that of the polymerizable core monomer when polymerized without the core dopant.

36. The method of claim 31, wherein energy is supplied during step (b)(ii).

37. The method of claim 32, wherein energy is supplied during step (c).

38. The method of claim 36, wherein said energy is in the form of heat.

39. The method of claim 37, wherein said energy is in the form of heat.

40. The method of claim 32, wherein said polymerization container is rotated during step (c).

41. The method of claim 31, wherein said polymerizable sheathing monomer and said polymerizable core monomer are different.

42. The method of claim 31, wherein said polymerizable sheathing monomer and said polymerizable core monomer are the same.

43. The method of claim 42, wherein the polymerizable monomer is methyl methacrylate.

44. The method of claim 31 further comprising the step of hot-drawing the article formed after the completion of step (b) at a predetermined temperature and speed to form a gradient index optical fiber.

45. A gradient index plastic optical article comprising:

a polymeric sheathing, which is at least partially transparent to light at at least one wavelength, including a sheathing polymer; and

a polymeric core, polymerized within said sheathing, which is at least partially transparent to light at at least one wavelength, including a core polymer and a specific overall concentration of a core dopant having a refractive index greater than that of the core polymer, said core dopant having a concentration gradient within the core in a specific direction that is established by redistribution of the core dopant during polymerization of a core solution including a polymerizable core monomer;

said polymeric sheathing being constructed and arranged so that a difference in refractive indices between the central axis of said polymeric core, having said overall concentration of core dopant, and said polymeric sheathing exceeds a difference in refractive indices between said central axis of said polymeric core, having said overall concentration of core dopant, and said sheathing polymer.

46. The article of claim 45, wherein said overall concentration of core dopant is zero.

47. The article of claim 45, wherein said polymeric sheathing includes a sheathing dopant having a refractive less than that of said sheathing polymer.

48. The article of claim 45, wherein the refractive index at the central axis of said polymeric core is greater than the refractive index of said polymeric sheathing, where said article conducts light at at least one wavelength with an attenuation less than 500 dB/km.

49. A gradient index plastic optical article comprising:

a polymeric sheathing, which is at least partially transparent to light at at least one wavelength, including a sheathing polymer; and

a polymeric core coaxially disposed within said sheathing, which is at least partially transparent to light at at least one wavelength, comprising a core polymer and a core dopant having a refractive index greater than that of the core polymer and present at a first overall concentration sufficient to create a difference in refractive indices between the central axis of the core and the sheathing of a desired value, said core dopant having a concentration gradient within the core in a specific direction;

said polymeric sheathing being constructed and arranged so that the maximum service temperature of the article exceeds that of an equivalent article except having a sheathing comprised only of sheathing polymer and having a second overall core dopant concentration required to create a difference in refractive indices between the central axis of the core and the sheathing equal to said desired value.

50. The article of claim 49, wherein said overall concentration of core dopant is zero and where said polymeric core has a refractive index gradient within the core in a specific direction.

51. The article of claim 49, wherein said polymeric sheathing includes a sheathing dopant having a refractive less than that of said sheathing polymer.

52. The article of claim 49, wherein the refractive index at the central axis of said

polymeric core is greater than the refractive index of said polymeric sheathing, where said article conducts light at at least one wavelength with an attenuation less than 500 dB/km.

53. A gradient index plastic optical article comprising:

a polymeric sheathing, which is at least partially transparent to light at at least one wavelength, including a sheathing polymer ; and

a polymeric core coaxially disposed within said sheathing, which is at least partially transparent to light at at least one wavelength, including a core polymer and a core dopant having a refractive index greater than that of the core polymer and present at a first overall concentration sufficient to create a difference in refractive indices between the central axis of the core and the sheathing of a desired value, said core dopant having a concentration gradient within the core in a specific direction;

said polymeric sheathing being constructed and arranged so that said light at at least one wavelength is conducted by the article with less attenuation than by an equivalent article except having a sheathing comprised only of sheathing polymer and having a second overall core dopant concentration required to create a difference in refractive indices between the central axis of the core and the sheathing equal to said desired value.

54. The article of claim 53, wherein said overall concentration of core dopant is zero.

55. The article of claim 53, wherein said polymeric sheathing includes a sheathing dopant having a refractive less than that of said sheathing polymer.

56. The article of claim 53, wherein the refractive index at the central axis of said polymeric core is greater than the refractive index of said polymeric sheathing, where said article conducts light at at least one wavelength with an attenuation less than 500 dB/km.

57. A plastic optical preform article comprising:

a polymeric sheathing, which is at least partially transparent to light at at least one wavelength and possesses a refractive index of a first value at said at least one wavelength, including a sheathing polymer and a plasticizer; and

a polymeric core, polymerized within said sheathing, which is at least partially

transparent to light at at least one wavelength, possesses a refractive index of a second value at the central axis of the core at said at least one wavelength, and includes a core polymer; said second value of refractive index exceeding said first value.

58. The article of claim 57, wherein the polymeric core has a refractive index gradient within the core in a specific direction.

59. The article of claim 57, wherein said preform can be formed into an essentially cylindrical optical fiber having an outer diameter less than 1 millimeter by extrusion.

60. The article of claim 59, wherein said fiber conducts light at at least one wavelength with an attenuation less than 500 dB/km.

61. The article of claim 57, wherein said preform can be formed into an essentially cylindrical optical fiber having an outer diameter less than 1 millimeter by hot-drawing.

62. The article of claim 61, wherein said fiber conducts light at at least one wavelength with an attenuation less than 500 dB/km.

63. The article of claim 62, wherein said fiber is hot-drawn from said rod at a drawing speed of at least 3 m/min.

64. The article of claim 62, wherein said fiber is hot-drawn from said rod at a drawing speed of at least 5 m/min.

65. The article of claim 57, wherein said plasticizer acts as a sheathing dopant having a refractive index which is less than that of said sheathing polymer.

66. The article of claim 57, when said polymeric core further includes a core dopant.

67. The article of claim 57, wherein said sheathing polymer and said core polymer are formed from the same polymerizable monomer.

AMENDED SHEET

68. The article of claim 67, wherein the polymerizable monomer is a perfluorinated monomer which yields an amorphous perfluorinated polymer upon polymerization.

69. The article of claim 57, wherein said sheathing polymer and said core polymer are formed from the different polymerizable monomers.

70. The article of claim 69, wherein the polymerizable monomer forming the sheathing polymer is a perfluorinated monomer which yields an amorphous perfluorinated polymer upon polymerization.

71. A method for making a gradient index plastic optical fiber comprising:

forming a polymeric preform rod comprising a polymeric sheathing and a polymeric core coaxially disposed within said sheathing, said polymeric core having a gradient in refractive index in a specific direction; and

hot-drawing said rod at a draw rate of at least 3 m/min into a fiber that conducts light of at least one wavelength with an attenuation less than 500 dB/km.

72. A plastic optical preform article comprising:

a polymeric sheathing, which is at least partially transparent to light at at least one wavelength, possesses a refractive index of a first value at said at least one wavelength, and includes a sheathing polymer; and

a polymeric core, coaxially disposed within said sheathing, which is at least partially transparent to light at at least one wavelength, possesses a refractive index of a second value at the central axis of the core at said at least one wavelength, and includes a core polymer and a core dopant having a refractive index greater than that of the core polymer and present at a specified overall concentration;

said second value of refractive index exceeding said first value at said at least one wavelength, with said specified overall core dopant concentration not exceeding 7.9%wt. and said article constructed and arranged to be formable into an optical fiber that conducts light at said at least one wavelength with an attenuation of less than 500 dB/km.

73. A plastic optical article comprising:

a polymeric sheathing, which is at least partially transparent to light at at least one wavelength, possesses a refractive index of a first value at said at least one wavelength, and includes a sheathing polymer; and

a polymeric core, polymerized within said sheathing, which is at least partially transparent to light at at least one wavelength, possesses a refractive index of a second value at the central axis of the core at said at least one wavelength, and includes a core polymer and a core dopant having a refractive index greater than that of the core polymer;

said second value of refractive index exceeding said first value by at least 0.01 at said at least one wavelength, and the operating temperature of the article being at least 40 degrees C.

having a refractive index which is greater than that of an equivalent polymeric core without the core dopant.

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